

‘The bearer of the mechanism of change’: Small-firm inventiveness and patenting in Norway¹

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1. Introduction

Firm-size is one of several variables within a larger system where technology, institutions, demand, strategic decisions and random processes play central roles in shaping overall economic outcomes. (Sutton, 1998) This chapter starts from the premise that the participation of small and medium-sized enterprises (SMEs)— and the conditions for their participation— is especially important for small open economies like the Norwegian case where firm demographics are dominated by relatively small companies. The role these firms play in knowledge generation and the problems they meet have implications for the working of the innovation system as a whole and for policies that address these.

The chapter draws on some aspects the unresolved (-able?) small versus big debate which traces back to disparate positions taken by Schumpeter. In this controversy, we are not primarily interested in the headline issue of which size-classes may or may not contribute most to technological progress. The purpose is to explore the role that different size classes play and to consider some implications to the working of the innovation system as a whole. We explore the contribution of the small firm to inventive activity in line with the Schumpeter’s early conjecture (Schumpeter, 1912; 1989), and consider problems this set of firms seem to face in managing their intellectual property in the growing 'market for technology', (Arora, Fosuri, Gambardella, 2000)

2. Small firms and Schumpeterian entrepreneurs

In the 1940s, Schumpeter (1942) made the familiar conjecture that the activities of dominant large and diversified firms drive technological change in the economic system. In doing so, these firms generate large knowledge spillovers that make their way into the economy in the form of lower costs and a widening range of goods. This conjecture, later championed by Galbraith, is generally contrasted to the somewhat contrary position in which a younger Schumpeter (1912; 1989) suggested that small enterprises might play a substantially more significant role to ‘spur growth’.

¹ Acknowledgements: This analysis is substantially based on a study sponsored by the SME Division of the World Intellectual Property Organization. A previous version of the paper was presented at the AEA conference in Singapore (2004). I especially appreciate the comments from William Lazonick and from Olav Spilling on previous versions of this paper. The usual disclaimer pertains.

This suggestion derives from the role given to entrepreneurship in the theory of economic development. In it, economic development is linked to ‘new combinations of productive means’ where the source of such novelty comes from outside the existing industrial establishment. Observing that it was not the owners of stagecoaches that built the railways, Schumpeter looks to ‘new firms’ as the source of novelty. (Schumpeter, 1989: 64ff) This novelty reaches beyond the run of the mill, ‘circular flow’ of economic activities to provide a driver of economic development. In the absence of a theory of the firm, the younger Schumpeter emphasized the role of the entrepreneur. His conception of entrepreneurship is instrumental. For Schumpeter, the role is about realizing new combinations and exploiting them in a process that leads to creative destruction. Langlois points out that this conception contrasts to ‘Kirzner for whom the role is about discovery and Knight (1924) for whom the role is about the faculty of judgment in economic organization’ (Langlois, 2005: 4). Below, we will look at the discovery dimension of entrepreneurship in terms of inventiveness, indicated by patent applications, and the exploitation dimension in terms of, indicated by the success rates of patents for different size-classes of enterprises. First we take a look a closer look at the relationship between firm-size and innovation.

SIZE-EFFECTS AND EMPIRICAL LIMITATIONS

This focus on the entrepreneur in new firms as ‘the bearer of the mechanism of change’ (Schumpeter, 1989: 61) in economic development has served to focus attention on the innovative activities of small firms. A whole literature has grown up to address size-effects in innovation, ranging from the more management to the more econometric-oriented literature. The evolution of Schumpeter’s thinking is particularly reflected in the distinction between Schumpeter Mark 1 and Mark 2 models which build on the concept of the technological regime (Winter, 1984): the first features small firms in competitive markets characterized by high turnovers in firm populations while the latter features large firms in stable oligopolistic competitive arrangements.

Although the literature has identified a set of factors which indicate that innovation increases more than proportionately with firm-size², the empirical evidence however has not been able to corroborate the size-effect in unequivocal terms. In fact the large number of empirical analyses has, by and large, been inconclusive, and some of the results even contradictory.³ Moreover, it has been shown that the measures to study size-effects involve serious difficulties which tend to lead to unreliable results. For example, R&D expenditure data is inherently problematic, especially dubious for smaller firms or populations for whom less formal innovative activities are important. (Albaladejo & Romijn, 2000) The need to rely on reported employment numbers also tends to engender problems, while industry-effects are difficult to control for (Cohen, 1995). In terms of output indicators, use of patents has a set of familiar limitations. One is that it is a one-size-fits all indicator (or one value regardless of the invention in question), leading to various yet ultimately incomplete attempts to gauge relative values of innovations. Other factors beg the whole question. What is ‘firm-size’ after all? One factor that calls this into question is the set of scale economies related to technology make up what Penrose (1959) calls ‘Technological economies’. Technologies that allow the production of larger numbers at lower unit cost may permit more efficient division of labor, economies of large-scale production and/or economies of (activity) expansion. Technological economies may therefore distort what ‘size’ means in terms of innovation.

2 See Acs & Audretsch (1990, 39-40)

3 For surveys, Kamien and Schwartz, 1982; Cohen, Levin, and Mowery, 1987; Cohen, 1995; Symeonides, 1996; and Dixon and Greenhalgh (2002).

A more general concern is that innovative activities are subject to the interaction of a large number of unobservable factors beyond size-related issues. Firm-level factors, especially those involving 'strategy, organization and finance' (cf Lazonick, 2004 for a discussion) affect the firm's attempts at realizing the 'new combinations' and exploiting them in the Schumpeterian sense. In addition to factors internal to the firm, there are also factors outside the boundary of the firm that, while unobservable, form the 'extended division of labour in the accumulation and application of knowledge' (Metcalf, 2001). They are important—perhaps increasingly so—in light of 'the institutionally contingent nature of the knowledge accumulation process, in which imperfectly perceived opportunities are pursued, producing rival and conflicting conjectures' (Metcalf, 2001: 562). This set of factors includes "market supporting institutions" which have been emphasized by Langlois & Robertson (1995) as facilitating organizational change and development. Institutions in the support-structure which are designed to influence the innovativeness of different types of firms include funding agencies, public research organizations, as well as a layer of institutions including patent-offices, standards development organizations etc. Such components link up with firm-level capabilities and provide the basis for an important type of interaction.

It is therefore important to the innovation and size debate to recognize that the, "firm propensity and capacity of innovation depends on the systems of linkages in which it is embedded, the institutions regulating the distribution and access to knowledge, the organization of different competencies and technologies combination" (Poti & Basile, 2000: 3). Although external to the firm, the contribution of these factors are not necessarily exogenous to the firm-level innovation processes. Yet, these factors are not usually taken into account when considering the relationship between firm-size and innovation.

INNOVATIVE ACTIVITY AND THE PATENT SYSTEM

The patent system forms one element of the institutional environment that, to a certain degree, conditions firm-level innovation. It can act to focus and to coordinate formal innovation processes both among and between private and public organizations in the economy. If its role constitutes a sector-specific 'market for technology', this entails that the patent system helps shape knowledge accumulation over time. The literature indicates that there are many factors, including firm-size, that condition the firm's choice when it comes to patenting. A review that could do justice to this vast and varied literature is obviously beyond the scope of this chapter.⁴ The role suggested and the role played are not necessarily the same. In terms of technological appropriability, it is worth observing that patents are not considered by business respondents to be the most important mechanism for protecting intellectual property (Levin et al., 1987)⁵. Secrecy is also considered a better appropriation-mechanism for manufacturing firms, than patents for process innovations. An update of this seminal study indicates that the importance of patents has decreased even more, although it might have increased for the largest firms (Cohen et al, 1997).

From the above, the implication is that the quality of the way these internal and external factors inter-work is arguably most important to the smaller enterprises, which may be most susceptible to the negative effects of a badly working system. This observation will become important when considering the withdrawal rate of particularly the smallest patent applicants, and what implications improving the system as a part of the division of labor may improve the contribution this population makes to increased variety.

⁴ See Griliches (1990), Takalo, 1999, Ernst (2001), Dixon and Greenhalgh (2002).

⁵ The results of the Community Innovation Survey reported below are consistent with this finding.

3. Firm-level aspects and patenting behavior

In light of the hunch that larger firms hold certain advantages in innovative activity, of the uncertainty surrounding the actual correlation between larger firm and innovation, and of the recognition that the surrounding system plays an important role in the innovation process, presumably more so in the case of small firms because of their resource problems, it makes sense to assume the importance of small firm innovation in the economy (i.e. Schumpeter in Business Cycles). The argument is not to regenerate the policy hype surrounding the little guy from the 1980s. Quite the opposite. The point is to create a more reliable picture of the contribution of small firms to generating new knowledge and the problems they face there. This might have implications for improving the system to support their innovativeness. That is the contribution we want to make in the following, in which we look into inventive activity through the lens of patenting activity.

BUSINESS SECTOR DEMOGRAPHICS

There are approximately 130,000 enterprises with salaried employees in Norway (1998) according to the employment register-data used here (see Annex). The demographics provide a first look at the question of diversity in the Norwegian economy. The principal characteristic is the extent to which SMEs absolutely dominate the Norwegian onshore economy in number. Over 96% are small and middle-sized enterprises according to the definition used here. A mere 3,700 Norwegian enterprises are large, meaning they employ over 100 employees or fulfill one of the other criteria.⁶ The bulk is to be found in the smallest size-classes, where over 60% are micro (1-4 employees) while 90% are small in the Norwegian classification.⁷

Table 1 illustrates how these enterprises break down according to industrial activity and size-class in a given year. The principal product or service of the largest company in the enterprise is used to assign an industrial activity. The breakdown of the Norwegian economy in this way indicates that a large majority of Norwegian enterprises operate in the Services sector (including Wholesale and Retail), while less than 10% are found in Manufacturing. Public administration, defense, and other services such as health and education (but not R&D services) account for a further 10% of Norwegian enterprises registered by NACE in this database. The ratio of larger firms is highest in four sectors: Offshore Oil & Gas, Public Services, R&D Services, and Electrical Equipment.

6 The basis definition is based on a total of 100 employees. In addition, smaller enterprises are considered “large” if:

1. they have more than 99 million NOK in annual turnover (an average of one million/employee)
2. they include more than 15 establishments
3. and/or they are registered holding companies (NACE 74150) with at least 30 employees (most will also qualify according criterion 1) Our definition means that an extra 1000 enterprises are considered large compared to if we had used the 100 employee cut-off.

7 A sizable, additional population (over 30% according to Spilling, 1999**) register no employees and are not included here. An additional 1 percent could not be associated with industrial activity.

Table 1: Number of Norwegian enterprises by size-class and field, 1998.

MAIN INDUSTRIES	ENTERPRISES			
	Large	SMEs	Total	RTCIndex (large)
BASIC SERVICES	1 201	57 546	58 747	0,7
BUSINESS SERVICES	277	18 395	18 672	0,5
ELECTRICAL EQUIPMENT	58	770	828	2,4
ICT AND POSTAL SERVICES	84	1 923	2 007	1,4
MACHINERY & EQUIPMENT	55	1 202	1 257	1,5
MANUFACTURE	503	8 734	9 237	1,9
NATURAL RESOURCES	77	8 514	8 591	0,3
OFFSHORE OIL AND GAS	45	81	126	12,3
PUBLIC & UIH SERVICES	1 095	12 062	13 157	2,9
R&D SERVICES	28	119	147	6,5
UNKNOWN	295	14 538	14 833	0,7
Grand Total	3 718	123 884	127 602	1,0
Percent	2,9	96,0		

Source: AA Register data: STEP

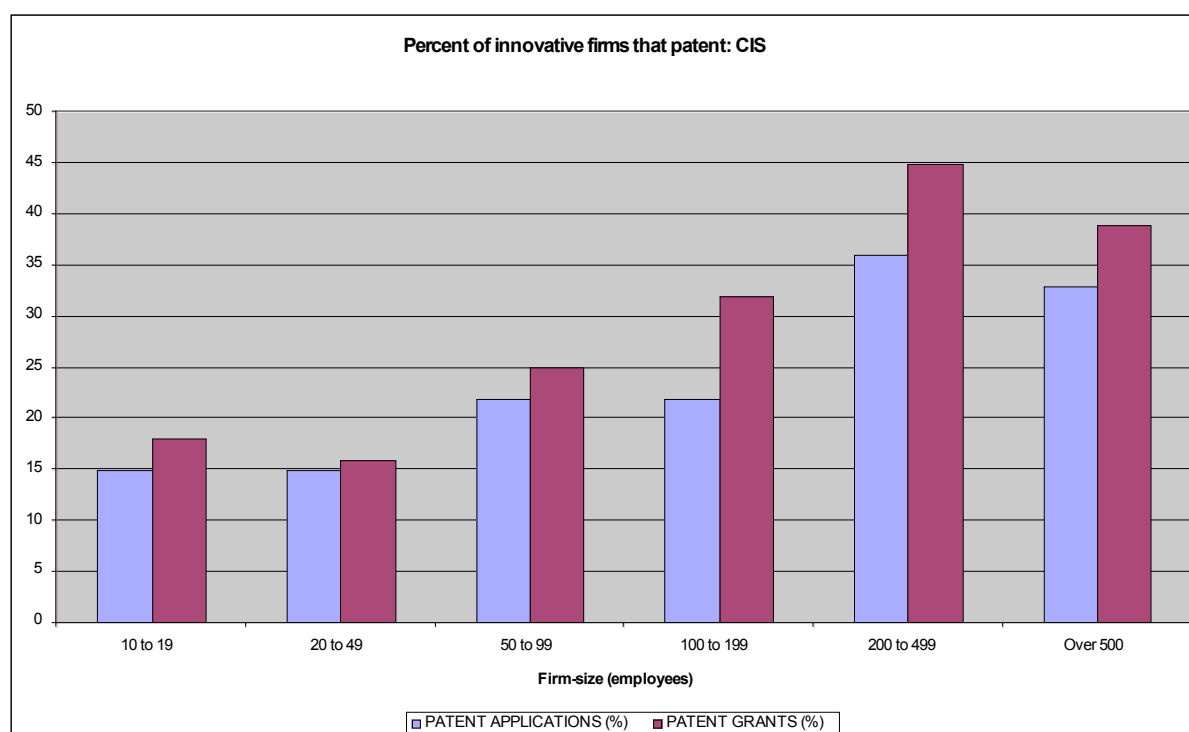
FIRM-SIZE AND INNOVATION

According to the most recent the Community Innovation Survey, only about 20% of Norwegian innovative firms⁸ use the patenting system while 30% indicate they rely on trade-secrets. There is an apparent correspondence between firm-size and patenting, with between 35-40% of the larger firms reporting applying for or receiving at least one patent in the 1999-2001 period. Patent intensity is highest in industries dominated by large firms in which there are relatively few small companies: the oil extraction sector (67% reporting applications, 73% reporting grants), the R&D services sector (67%, 33% respectively), and the chemical production sector (50%, 56%).

The survey is based on a sample of 3,400 enterprises which attempts to be representative both in terms of industry and geographical location. It however leaves out the smallest size-classes and relies on weighted averages for the smaller size classes. It is also selective in including sectors that are not expected to innovate or patent (e.g. restaurants and hotels). The survey results serve to indicate that the level of patenting in Norway is relatively low, that patenting may be size-dependent, and that largest firms are not those that patent most.

⁸ Those who have introduced new products or processes in the past three years.

Figure 1: Patenting among innovative enterprise by firm-size (employees) in the Community Innovation Survey: 1999-2001. (N=3416)



Source: Statistics Norway and NFR: http://www.forskningsradet.no/bibliotek/statistikk/indikator_2003/kap5.html

PATENTING ENTERPRISES IN THE PERIOD 1995-1999

There is some question whether the survey is successful in representing the patenting behaviour of innovative firms in Norway. The major concern is what the smallest firms, i.e. most Norwegian firms, are contributing to the production of new knowledge in the country. Based on Iversen (2004) this section takes a unique look at the contribution of the economic sector to Norwegian patenting.

In the period 1995-1999 some 3,670 entities were involved in a total of 7360 domestic patent applications in Norway. The majority of these assignees were individuals with no apparent affiliation (2039).⁹ A further five hundred companies in the patent record cannot yet be linked to number of employees.¹⁰ In a given year (1998), 490 enterprises were involved in 890 Norwegian patents, while the remaining 580 involved 458 individuals with no visible affiliation. For the five year period 1995-1999, we can identify a population of 1096 firms involved in patent applications. In addition to the 534 unidentified companies, 361 patenting enterprises are micro (1 to 4 employees), 259 are small (4-49), 181 are medium (50-99), and the remaining 295 are large. The next table indicates the proportion of firms in these size-classes that patent (assignee on at least one patent), by business sector.

This full-count exercise indicates that around 3% of all Norwegian enterprises patent. Around 8% of large firms applied for at least one patent in the period, while less than one percent of

⁹ This set will include the contribution of researchers at universities, who until 2003 were entitled to patent their own research results.

¹⁰ Since we are looking at enterprises with taxable employees, these 500 include single-entrepreneur companies. Better correspondence is expected when we link more years of the employer registry. Pending that, it is fair to assume that these firms are most like not to be large enterprises.

the SMEs did so. These gross figures reflect the fact that the activities of many firms are not relevant for patenting (or patenting is not relevant for their activities). The right hand columns reflect the industry effects. The patenting of large firms varies between 2.5% of Basic Services enterprises with patent applications, to 75% for Machinery and Equipment. The most patent intensive of the SME classes is the category of R&D Services.

Table 2: Number and percentage of Norwegian enterprises involved in Norwegian patent applications by size-class and business sector: 1995-1999.

BUSINESS SECTOR	PATENTING FIRMS			% patenting enterprises		
	LARGE	SMES	TOTAL	LARGE	SMES	TOTAL
BASIC SERVICES	30	132	162	2,5	0,2	0,3
BUSINESS SERVICES	29	199	228	10,5	1,1	1,2
ELECTRICAL EQUIPMENT	25	44	69	43,1	5,7	8,3
ICT AND POSTAL SERVICES	4	21	25	4,8	1,1	1,2
MACHINERY & EQUIPMENT	41	77	118	74,5	6,4	9,3
MANUFACTURE	100	156	256	19,9	1,8	2,8
NATURAL RESOURCES	1	25	26	1,3	0,3	0,3
OFFSHORE OIL AND GAS	16	4	20	35,6	4,9	11,0
PUBLIC & UIH SERVICES	3	16	19	0,3	0,1	0,1
R&D SERVICES	13	20	33	46,4	16,8	22,4
UNKNOWN	33	107	2713*	11,2	0,7	17,7
Grand Total	295	801	3669	7,9	0,6	2,8

* includes: unaffiliated individuals (2039), unregistered (463), unknown (71)

On the other hand, it is interesting to note the spread among patentees in nominal terms: for example, it is worth noting that a substantial number of small Basic Service companies are patenting. We want to focus on the contribution of the small companies in this setting. This breakdown leaves us with the observation that the smallest enterprises provide most of the identifiable (and probably the as yet unidentified) population of patent assignees in nominal terms. The fact that the number of patenting micro enterprises overshadows large ones is no surprise from the perspective that they represent over 60% of the 130,000 Norwegian enterprises: only 0.44% of the micro firms are involved in patenting. However, for some sectors, the contribution is substantial in relative terms as well. Patent intensity among the smallest enterprises is relatively high especially the case of the R&D Service sector, but also in the electrical equipment and the machinery & equipment sectors. These are sectors with more than the average number of large firms (see chi-squared values above).

PATENT APPLICATIONS BY ECONOMIC SECTORS, MARKET STRUCTURE, AND SIZE

The diversity of small firms in Norway has grown quickly surpassing large firms in gross patenting during the late 1990s (Iversen, 2003). The 801 identifiable SMEs were involved during the last half of the decade in a total of 1597 patent applications, a hundred more (1498) than the Large. We need not assume that the 360 Micro-Firms are all potential Cisco Systems to argue that small firms can contribute significantly to knowledge-production. They can represent early pushes in industry life cycles and may in this way contribute to industrial rejuvenation. Nor should one romanticise about this contribution. However, it seems appropriate to make the point that although only 0.6% of Norwegian small and medium-sized

enterprises (as against 8% of the larger ones) patented in the late 1990s, the 800 firms contribute to the variation of the knowledge stock on a general basis.

Table 3 introduces the number of applications, indicating also the intensity of patenting in terms of the average number of applications per applicant for the 1995-1999 period. The greatest number of applications is in Business Services followed by Manufacture.¹¹ The average number of applications per applicant is on the other hand highest for the small sectors in which large enterprises seem dominant (offshore oil and gas and R&D services). On the face of it, SME patenting shows greatest relative strength in the small sectors as defined here. SMEs are more active than their relative patenting intensity would indicate, for example in the R&D services sector, where the average number of applications per applicant is higher than the average. Small and medium-sized enterprises show relative strength in categories where there are both low numbers of enterprises and number of patents.

Table 3: Number and percentage of Norwegian patent applications by size-class and business sector.

	applicants		applications		appl per applicant		CHI*2
	total	smes	total	smes	total	smes	sme patents
BASIC SERVICES	162	132	303	222	1,9	1,7	1,4
BUSINESS SERVICES	228	199	706	507	3,1	2,5	1,4
ELECTRICAL EQUIPMENT	69	44	159	63	2,3	1,4	0,8
ICT AND POSTAL SERVICES	25	21	60	47	2,4	2,2	1,5
MACHINERY & EQUIPMENT	118	77	274	135	2,3	1,8	1,0
MANUFACTURE	256	156	697	250	2,7	1,6	0,7
NATURAL RESOURCES	26	25	34	33	1,3	1,3	1,9
OFFSHORE OIL AND GAS	20	4	109	7	5,5	1,8	0,1
PUBLIC & UIH SERVICES	19	16	29	25	1,5	1,6	1,7
R&D SERVICES	33	20	177	131	5,4	6,6	1,4
UNKNOWN	140	107	4810**	177	34,4	1,7	0,1
Grand Total	1096*	801	3095**	1597	2,8	2,0	1,0

* excluding: individual (2039), unregistered (463), unknown (71)

**excluding: individual (3182), unregistered (985), unknown (96)

A closer look reveals that size and sector do condition patent activity in fundamental ways, when the number of applications is compared to total numbers of enterprises. Table 4 presents a composite picture which indicates in descriptive terms how the propensity to patent varies according to market structure, economic sectors, and firm-size. A central aspect of the table is the presentation of the average number of applications per 100 firms for the different industrial sectors. Here the distribution of all Norwegian enterprises in these size and activities (1998) is compared with the number of applications for a five-year period (1995-1999).

This measure reveals that for the period an average of three patents were applied per 100 Norwegian firms. The greatest propensity to patent is among R&D services with an average of 1.2 applications per enterprise (over 5 years). This is followed by the Offshore sector, at 0.6 patents per enterprise, and Machinery & Equipment at 0.2 applications per enterprise. Those areas with the lowest patent propensity is, not unexpectedly, the primary and tertiary sectors, including the public sector.

¹¹ Business services include holding companies for large corporations.

SIZE AND INDUSTRIAL SECTOR

The table also indicates to what degree the propensity to patent is size related. Large firms are the most intensive applicants.¹² The average propensity is 40 patents per 100 enterprises for the five year period. This is eight times that of medium firms, 20 times that of small firms and 40 times that of Micro firms. Its strength is particularly demonstrated in Machinery & Equipment (12 times the industrial average), Business Services (13 times the average for the industry), Manufacture (11 times the industrial average) and Electrical Equipment (9 times the industrial average).

Breaking up the comprehensive SME category reveals that the intensity of patent applications is lowest among micro-enterprises. This size-class applies on average for 1 patent per 100 enterprises in the five year period. This rate is strongly influenced by which field the enterprise is in. Micro enterprises (1-4) that work in the R&D Activities Sector, applied for 121 patents per 100 enterprises, which is above the average for that sector. The patenting activity is also near to the industry average in the ICT services sector. The patenting intensity of small firms is on average twice as high. If we remove the unknowns, its 2 /100 enterprise average is on par with the total population. It is however half the intensity of micro-enterprises in R&D activities, and considerably higher in Business Sectors, where it is on par with the industry as a whole. Medium-sized enterprises demonstrate a considerably higher propensity to patent, at 5 applications per 100 enterprises, or one per year. The relative strength of medium-sized firms is shown particularly in R&D Activities, Machinery & Equipment, and Electrical Equipment.

Table 4. Sector and size-specificities of Norwegian patenting: Number of Applications (1995-1999) per 100 Norwegian Enterprises, by size and industrial activity and market dimensions

	applications		Applications per applicant		applications per 100 firms			market dimensions	
	total	smes	total	smes	total	large	smes	market size**	ratio large firms***
OFFSHORE OIL AND GAS	109	7	5.5	1.8	60	227	9	small	high
ELECTRICAL EQUIPMENT	159	63	2.3	1.4	19	166	8	small	medium
R&D SERVICES	177	131	5.4	6.6	120	164	110	small	high
NATURAL RESOURCES	34	33	1.3	1.3	0	1	0	medium	low
ICT AND POSTAL SERVICES	60	47	2.4	2.2	3	15	2	medium	low
MACHINERY & EQUIPMENT	274	135	2.3	1.8	22	253	11	medium	low
MANUFACTURE	697	250	2.7	1.6	8	89	3	medium	medium
PUBLIC & UIH SERVICES	29	25	1.5	1.6	0	0	0	large	medium
BASIC SERVICES	303	222	1.9	1.7	1	7	0	large	low
BUSINESS SERVICES	706	507	3.1	2.5	4	72	3	large	low
UNKNOWN*	4176*	177	34.4	1.7	11	125	1	large	low
Grand Total	3095	1597	2.8	2.0	3	40	1		

*excludes individual patents (3812), includes unregistered (985) and unknown firms (96)

**small=under 1000 entities, medium= 1000<x<10000, large>10000

***low=< 5 percent, medium= 5<x<10%, high=>10%.

MARKET-STRUCTURE

In terms of 'Market structure',¹³ the gross number of enterprises in a given industry provides a measure of market concentration. The number of patent applications for 1995-1999 can thus

12 This changes fundamentally when we compare applications per employee, but that is for another study.

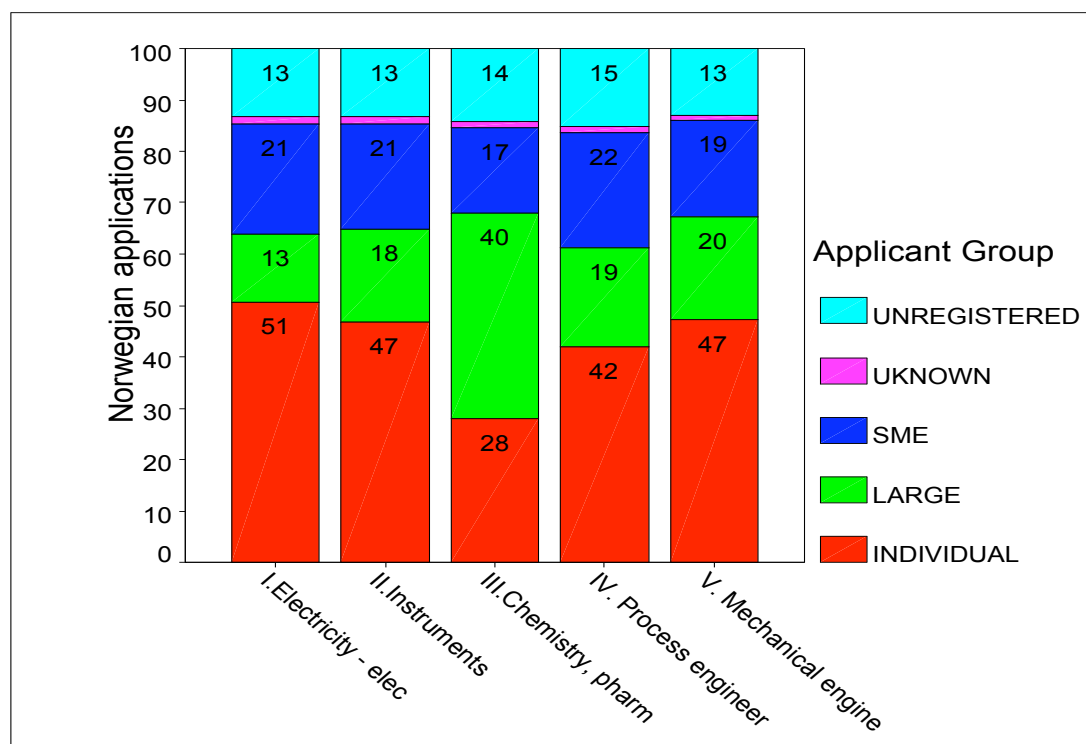
13 See Nielsen et al (1998) for elements of this approach.

be seen in terms of whether the industrial sector of the applicants is small (under 1000 entities), medium-sized (between 1000 and 10,000) or large (more than 10,000 enterprises). A similar descriptive idea of market dominance is provided by looking at the ratio of large firms in the different industries. The ratio of large companies are divided into low (less than 5 percent of the enterprises are large), medium (between 5 and 10 %), and high (greater than 10%).

The table ranks the industries based on the size of the market (where the Schumpeterian conjecture would suggest a correlation) and then by the total number of applications in ascending order. In descriptive terms, there seems to be some connection between small market size, higher than average concentrations of large firms, and patent intensities (number of applications and average number of applications per active enterprise). Noting Machinery & Equipment and Manufacture, the correlation does not seem completely clear. Further analysis is needed.

Given the large number of independent individuals and the difficulties in classifying some of the enterprises by industry, we look at some characteristics of the patent applications in order to find out more about the applicants. Here we briefly compare the technical areas of the patents (according to patent classes) with the size-classification of 12,894 Norwegian applicants from 1990-1999. This gives us a full-tally on which to discuss the distribution of applicants by size and activity.

Figure 2. Percentage of Size-classes applying by Technical area of applications, % (N=12,984)



Source: Iversen (2003)

The fact that large firms patent differently than SMEs comes more strongly to the foreground in this figure.¹⁴ Large firms are in relative terms most active in the Chemical applications, and least in Electricity, which includes ICT patents. SMEs are represented strongest among the many applications that go under the heading of Mechanical Engineering and Consumer goods. They are also reasonably evenly spread. The patenting behavior of the large population of independent applicants is most variable and stands in opposition to that of large enterprises. Individuals are most highly concentrated in Electricity and Electrical Engineering, and least in the Chemicals and Chemistry field.

4. Firm-size and the success of the applications¹⁵

The successful conversion of knowledge production into new products and services is contingent on a multitude of factors in competitive markets, as discussed above. Many of these factors may be external to the firm. In light of the above discussion, this final section explores Norwegian patenting behavior for indications as to how the knowledge market functions in Norway. As with the previous two figures, this section is based on the 6,303 Norwegian entities who, together, were involved in 14,319 ‘active’ domestic Norwegian patents during the 1990s.¹⁶ This data allows us to observe how different size-classes of firms not only enjoy higher levels of success in terms of grants: more to the point, it clearly makes the point that the smaller the firm, the higher the probability that it will itself withdraw the application. Withdrawal rates reveal something about the way individual firms evaluate the worth of their invention and their ability to realize it.

The question of withdrawal as opposed to application brings us back to the point that, for Schumpeter, the role of the small-firm entrepreneur substantially involves exploiting the novelty it generates. This conception, as Langlois (2004) observed, contrasts particularly to Kirzner’s (1973) where the emphasis was more on the entrepreneur’s ability to discover new opportunities. In terms of patenting, the fact that a firm applies for a patent can be associated to this discovery dimension. It indicates that the firm has accumulated novel knowledge for which it had considered at the time of application at least to represent some commercial potential.

Whether the firm is able to exploit the potential of the application in the sense emphasized in Schumpeter is another question. The tendency for patent applicants to withdraw their applications indicates the inability of the firm, for whatever reason, to realize the potential indicated by the application. There may be many practical considerations at work here. On the one hand, it can indicate that the application was poorly framed and the applicant had reason to believe that it would not be granted in an acceptable form. An equally likely reason for why an applicant does not follow up the application (following a fee schedule) is that it has run out of the funding necessary to bring the idea to market (cf. the capitalization process) and/or that it has lost faith in the idea’s ultimate success seen in relation to costs. We can therefore interpret withdrawal to mean, in one way or another, that the initial value expectations by the applicant became disappointed.

14 For full counts for the different areas, see above. It is otherwise reassuring to see that the Unregistered and the Unknown categories are spread evenly across these technical areas

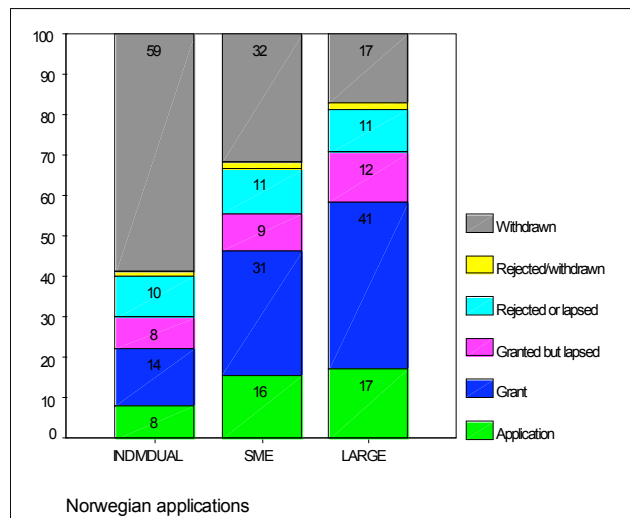
15 This section draws on Iversen E. & A. Kaloudis (2002). Valuation as a tool to sustain innovation. UNECE High Level Task Force on Valuation and Capitalization of Intellectual Assets, <http://www.unece.org/operact/enterp/documents/iver.pdf>. Adapted in E. Iversen & A. Kaloudis (2006). IP-Valuation as a Tool to Sustain Innovation. In Bosworth & Webster (eds) The Management of IPRs. Edward Elgar. Forthcoming.

16 By “Active”, we mean any patent that was applied for and/or granted during the 1990s AND any patent applied for before then but granted during the nineties.

SIZE-DEPENDENT PATENT-WITHDRAWAL

A major difference between smaller and larger applicants involves the ‘success’ of their patent applications. The level of non-grant—especially cases in which the applicant withdraws his application—is dependent upon size. More than 40% of the Norwegian applications are withdrawn by the applicant. In the population of active patents during the 1990s (which has been widened to include granted patents), about a third (34%) have been granted, 12% remain in examination, and the rest have terminated with a non-grant. Forty percent of the SME applications are granted. Large enterprises as a group enjoy a success rate of over 50% and a withdrawal rate that is half that of SMEs and a third of that of independent applicants. There may be many factors behind the differences in success rates, where “success” is measured in patent grants. At least part of the explanation, however, is probably a better working understanding of the IPR-System, and the fact that it is more comprehensively built into the enterprise’s business strategy. In principle, a national IPR-System should aim to reduce the number of withdrawal that result from misconceptions of the system or in poor competences in dealing with it.

Figure 3. Norwegian applications¹⁷ by size-class and status .(N=12,277)

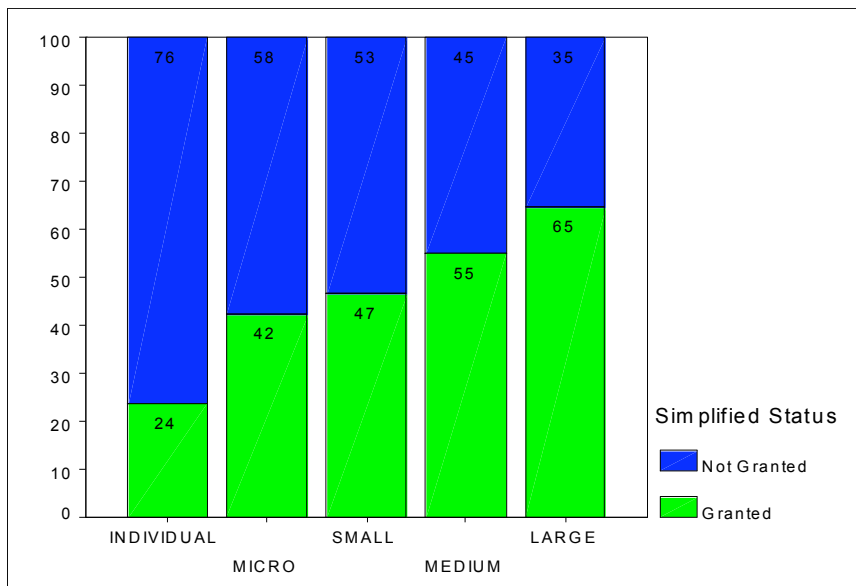


Source: Iversen (2003)

The following figure breaks down the SME definition to see if indeed the level of non-grant (especially because of withdrawal) is dependent on size. Those applications that are still in application are removed as are the Unknown and Unregistered enterprises. In this way, the size-based trend becomes more clear. Patent Grants climb with size, from 24% in the case of Individuals, to 65% for Large Enterprises.

¹⁷ 2,042 Unknowns and Unregistered applications are removed.

Figure 4. Norwegian applications according to Size-Group and simplified status. Percentages of processed applications (N=5,751)



Source: Iversen (2003)

The fact that SME patents are more often withdrawn than those of large entities raises suspicions that smaller entities find it more difficult than larger ones to follow through on their attempts to innovate. In this vein, the figure shows that ‘success’ among Norwegian patenting is indeed dependent on firm size. There may be many factors behind the differences in success rates, where “success” is measured as non-withdrawal. Part of the explanation is probably to be found at the firm level: larger firms have a better working understanding of the IPR-System, they have internal resources (and thus staying power and fighting power in litigation), and that they have a more conscious and better informed policy about intangible assets built into the enterprise’s business strategy. Another reason may involve the quality of the patents. Those of small firms might in general be of less potential value, making the pursuit of a patent more costly than benefits expected to accrue during its commercialization. A last possibility is that signals from the Patent Office indicate that the idea may not in its current form fulfil one or more of the criteria for patenting.

The reason that a much larger proportion of SME applications is withdrawn (1/3) than large enterprise applications (1/6) has to do with such factors. However, it presumably also involves factors that are external to the firm, especially access to funding at critical stages in the development process. In general, the variable withdrawal rates suggest that several types of factors that might be at play, including:

- (i.) that smaller actors, especially independent inventors, tend to overestimate the value of their intangible assets going into a formalization process.
- (ii.) that smaller applicants are forced to cut losses during the long development process because of difficulties accessing complementary assets—especially funding. This suggests that many, perhaps good ideas, are not developed. (capitalization problem and the functioning of investment markets)
- (iii.) and that smaller applicants have a poorer working understanding of the patent system and could use a greater degree of assistance when approaching it.

A better understanding of what leads to this disproportionate withdrawal of patent applications by smaller enterprises is needed. On the face of it, the substantial rate of miscarried patent applications represents a loss of resources (both time and money) for a population who assumedly can ill-afford it. Given that small firms tend to be more dependent in the 'extended division of labor' on outside factors, one question this raises— pending a study into the underlying causes— is thus whether the inability of small-firms to follow through on their patent applications is size-related and structural. If so, the question then turns to whether there is a case to improve the support structure in order to help firms to overcome these problems including making better decisions about patenting.

5. Conclusions

Economic development is closely connected to knowledge creation, dissemination, and utilization in its economic agents. In the theory of economic development, Schumpeter emphasized the role on the entrepreneur in new firms as 'the bearer of the mechanism of change' (Schumpeter, 1934: 61). This chapter has looked at the inventiveness of small firms in general, indicating that patenting among Norwegian small firms increased substantially during the 1990s. It presented and explored a unique dataset which shed light on how the propensity to patent varies by firm-size, industrial sector, market characteristics, and other aspects of firm populations. The chapter underlined the correlation between firm-size and the success of patent applications, revealing a size-related tendency to withdraw patent applications emphasizes the importance of improving firm-internal processes. The role these firms play in knowledge generation and the problems they meet have implications for the working of the innovation system as a whole and for policies that address these.

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Annex: The compilation of the databases and their analysis

The database analysis conducted in this study is based on coupling the identity of Norwegian applicants for trademark and patents with firm-level information available for a full-count of Norwegian enterprises. We linked the Norwegian Patent Office databases covering patents and trademarks with publicly compiled registry-data covering all Norwegian enterprises. This was the clearly the best possible way to approach the question of who uses the patent and trademark systems in Norway. It was pursued because it could provide a totally unique and detailed picture of Norwegian applicants for these two types of rights.

Some problems were inevitably confronted which required more work than anticipated. The major reason for this was the fact that the link between databases had to be done on the bases of names (and zip codes) of the Norwegian applicant: there was no reliable identifier in the applications that would allow a join with the public registry data (see recommendations). Since errors or variations occur in the names columns of the databases involved, this required different approaches to make the links combined with a large degree of manual checking of the links.

Below we provide more information about the NPO databases and the Registry data, how the databases were linked, and assumptions made in their interpretation.

THE NPO DATA

A. The selection of the trademark and patent data was done along the following lines:

1. The Time-Span: all applications that were active during the 1990s. By this we mean all applications that were received from January 1 1990 to December 31, 1999, or any application that was granted during that period, regardless of application date.
2. "Norwegian" applications are application in which at least one of the applicants (not necessarily inventor) provide a Norwegian address. Only a small proportion of the total applicants were mixed and most of these had the Norwegian addressee as the primary applicant.
3. The information included information about **who** of the application (the names of all applicants and an unreliable identity number), the **where** (applicant address and zip-code), the **when** (application date and, if applicable, grant/registry date), the **what** (application titles and the primary IPC class), and the **how** (the status of the patent application, for example whether granted, whether withdrawn/rejected and under what conditions, or whether still under examination).

B. This data was then cleaned, and the following links made:

1. the zipcodes were associated to county and district-levels via the Norwegian Post's database.
2. the primary IPC classes of the patent applications were associated to Technological Areas by a widely-used Correspondence Key: the INPI/OST/ISI Key, Version 3.

THE REGISTRY DATA

This data was then associated with full-count registry data of Norwegian enterprises. The enterprise-level information used here includes information about firm-size, industrial activity, number of companies, (in later years) annual turnover etc. It comes from a unique, publicly assembled registry covering all active Norwegian companies. This type of registry is only found in a limited number of countries, especially the Nordic countries.

The registry is put together by Statistics Norway on the bases of firm-level information from the Brønnøysund Register Centre (<http://www.brreg.no/english/>) register of Norwegian enterprises and companies and the National Insurance Service's (Rikstrygdeverket) registry of active employees and employers. This database gives us a picture of all enterprises (and subsidiary companies) who formally pay wages to at least one person. (a registered workforce of about 2million)

A. The selection of the registry data was conducted along the following lines:

1. Enterprises (foretak) versus Establishments (bedrift): the enterprise-level was used and all values (number of employees and turnover) were aggregated up to this level.
2. Industrial activity: The enterprise's industry is defined via the EU's NACE classification (Nomenclature générale des Activités économiques dans les Communautés Européennes). The activities of enterprises previous to 1994 when the NACE was introduced in Norway have been linked to the previous classification system used by Statistics Norway (=SIC). Industrial activity is based on the enterprises' main product. In aggregating up from establishment to enterprise, the dominant NACE class has been used. (see NACE 74150, Holding company as special case) The most up-to-date classification is used if this had changed over time.
3. Zipcodes were associated to county and district-levels via the Norwegian Post's database, thus allowing us an additional criterion on which to check the identity of the applicants.

B. This data was then cleaned, and the data defined in the following way:

1. DEFINING "LARGE" Enterprises

Large enterprises are basically those with a total of at least 100 employees. Three additional criteria are used to define what is considered 'large' here as well. The first supplement involves enterprises which include at least 19 'establishments'; these include Norwegian parts of large franchises. Enterprises defined under NACE 74150 (Holding corporations) that employ more than 30 are also considered large. These include diversified corporations whose management is defined as a separate enterprise. In order to pick up all large scale operations, enterprises with a combined turnover of 99 MKR in at least one of the years for which we have turnover data (1997-1999) are also considered large.

There is a disruption at around 1995 in the data, both regarding NACE code and number of employees. One source of these difficulties is the transition to NACE from ISIC Rev 2 classification system. Another is the way the firm-level information was compiled. A third is the fact that several major Norwegian companies were undergoing restructuring at that time. (for example the telecoms operator, Telenor) These potential sources of errors have been screened, and any remaining inaccuracies are not expected to affect the results.

2. DEFINING "INDIVIDUAL"

The classification 'individual' is based on applications with no apparent affiliation with an enterprise or other organization. These are applications in which the assignee is listed on the basis of a first and last name, and which do not connect with the significant number of individually run enterprises when the county is also checked. This population potentially includes inventions made at universities, since Norwegian law currently allows academic researchers to own their inventions. The addresses were hand-checked to help prevent incorrectly classifying them.

3. DEFINING "UNKNOWN"

A number of IPR applicants whose names seem to be that of an enterprise or institution would not connect with the AA register or Enhetsregister. (2001) In other words, these entities are not registered in the registry material. These may be companies who died before they could be registered or who are in the process of registering. Or there might be a mistake that makes it impossible to link the name in the application to the name in the registry database. This population was manually checked to try to isolate any apparent mistake. We assume that entities in this population are most probably not large companies.

4. DEFINING "UNREGISTERED"

Another population has been called 'unregistered'. These include entities that have an identifiable enterprise number but which cannot be connected with substantive information in the registry database we have. This indicates that there are no employees, especially if the link was made with the registry-data in the period, 1989-95.